

# NUS School of Computing

## Answer Key for Self Diagnostic Assessment for Computational Thinking and Programming Methodologies

June 22, 2018

### 1 Language-Agnostic

1. A game of "Pick Up Sticks" is played between two players with an initial pile of sticks. Each player takes turns in picking out 1 to 3 sticks from the pile. Whoever takes the last stick loses the game.

Suppose it is your turn to pick sticks from the pile, which of the following situation would be least favourable to you?

*Ans: A pile of 9 sticks. Clearly, picking from a pile of only 1 stick is a loss. You can force your opponent to lose if you are picking from a pile of 2 to 4 sticks. But picking from a pile of 5 sticks may lead to a loss.*

*Since 5 sticks is a potential loss, you can force your opponent to lose if you are picking from a pile of 6 to 8 sticks. And picking from a pile of 9 sticks may again lead to a loss.*

2. A bunny would like to get from one side of the river to the other side. There are  $n$  rocks separating the two sides with equal spacing, and the bunny can only hop across  $j$  ( $\leq n$ ) number of rocks (or steps) in a single jump.

Using an example of  $n = 4$  and  $j = 3$ , suppose the bunny needs to get from **s** to **d** with rocks denoted by **x** in between.

Let capital letters denote the current position of the bunny.

Initially:

**S x x x x d**

Hop 1 (hopping 3 steps towards the right):

s x x X x d

Hop 2 (hoping 3 steps exceeds d and bounces back):

s x x x X d

Hop 3 (hoping 3 steps towards the left):

s X x x x d

Hop 4 (hoping 3 steps exceeds s and bounces back):

s x X x x d

Hop 5 (hoping 3 steps towards right):

s x x x x D

Which of the following configurations of  $n$  rocks and  $j$  steps would result in the bunny NOT being able to reach its destination?

*Ans. The least common multiple of  $(n + 1)$  and  $j$  is even. There are  $(n + 1)$  steps between the two sides of the river. To be assured that the bunny jumps back to the original side without first landing at the opposite side, (and hence never reach its destination), there should an even multiple of  $(n + 1)$  steps.*

*Within this even multiple of  $(n + 1)$  steps, the bunny can take any multiple of  $j$  steps.*

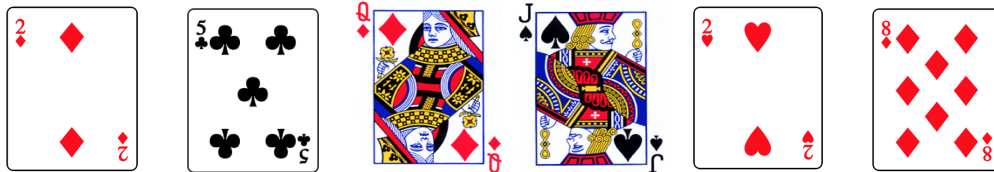
*So the  $\text{lcm}(n + 1, j)$  being even guarantees that the bunny will not reach its destination.*

3. Santa is about to deliver the 2000 wrapped boxes of identical pairs of socks to 2000 families. However, Santas elves have mistakenly wrapped a pair of heavily soiled socks. Time is running out. Which one of the 2000 boxes contains the dirty socks? There is no time to unwrap all the boxes, find the one with the dirty socks, and wrap the rest up again. We know that the soiled socks are heavier. There is a huge balancing scale which the elves may use, but there isnt enough time to put the boxes one at a time on the balancing scale. How can you help Santa to locate the dirty socks as quickly as possible? Using your method, at most how many times the balancing scale will be used to locate the box containing the dirty socks?

*Ans. By dividing the boxes by half, we use divide-and-conquer technique to locate the box containing the dirty socks. The first balancing is done between two groups of 1000 boxes each. The balancing is then continued*

*with the boxes on the side that is heavier, and the process repeats until a pair of boxes are weighed against each other. At most 11 weighings are required.*

4. Suppose the following cards are shuffled and put in a pile, face down.

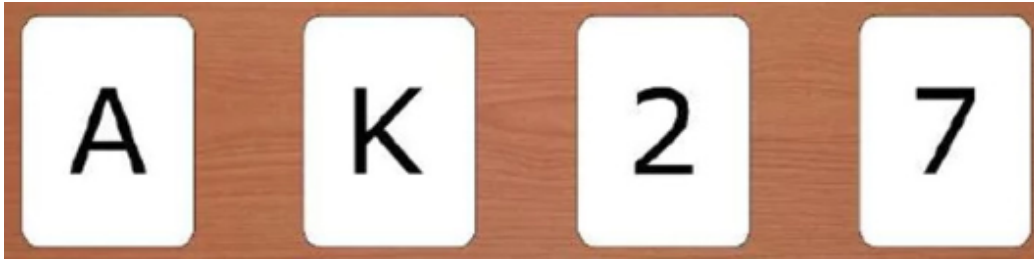


Assuming that “A”, “J”, “Q” and “K” have values 1, 11, 12 and 13 respectively, find the order of the cards in the pile from top to bottom if you are given the following clues:

1. The eight is somewhere above the “J”.
2. A two is directly above the five.
3. The spade is somewhere above the heart.
4. One black card is directly above the other black card.
5. The bottom cards value is the sum of the values of three other cards.
6. A red card is on the top of the pile.

*Ans. From top to bottom: 8 diamond, 2 diamond, 5 club, Jack spade, 2 heart, Queen diamond.*

5. Suppose you are told that if a card has a vowel on one side, it must have an even number on the other side. Given the following four cards, you are to choose two cards to turn over to prove or disprove the above rule. Which two cards will you choose?



*Ans. Cards “A” and “7”.*

## 2 C

1. Given the following C program fragment:

```
int list[5] = {3, 2, 4, 1, 0}, i = 0, temp;

while (i < 5) {
    if (list[i] != i) {
        temp = list[i];
        list[i] = list[list[i]];
        list[list[i]] = temp;
    } else {
        i++;
    }
}
```

What are the contents of array list after executing the program?

*Ans. An infinite loop occurs.*

2. Given the following structure definition:

```
typedef struct {  
    char name[40];  
    int age;  
} Person;
```

Which of the following functions correctly return(s) the sum of ages in the first  $n$  elements of array `pa`?

```
i. int ageSum(Person pa[], int n) {  
    int sum = 0, i;  
  
    for (i = 0; i < n; i++) {  
        sum += pa[i].age;  
    }  
    return sum;  
}
```

```
ii. int ageSum(Person pa[], int n) {  
    Person *p = pa;  
    int sum = 0, i;  
  
    for (i = 0; i < n; i++) {  
        sum += (p+i)->age;  
    }  
    return sum;  
}
```

```
iii. int ageSum(Person pa[], int n) {  
    int sum = 0, i;  
  
    for (i = n-1; i > 0; i--) {  
        sum += pa[i].age;  
    }  
    return sum;  
}
```

*Ans. i. and ii. only.*

3. Given the following function:

```
void foo(int *x, int *y, int *z) {  
    int temp;  
  
    temp = *x;  
    *x = *y;  
    *y = temp;  
  
    *z = *x + *y;  
    return;  
}
```

What is the output of the following code fragment?

```
int i = 1, j = 2, k = 3;  
  
foo(&i, &j, &k);  
printf("%d %d %d; ", i, j, k);  
  
foo(&i, &i, &i);  
printf("%d %d %d\n", i, j, k);
```

*Ans. 2 1 3; 4 1 3.*

4. Study the following `doIt` function.

```
void doIt(int x, int y, int *count) {
    int result;

    if ((x == 1) || (y == 1)) {
        (*count)++;
    } else {
        doIt(x-1, y, count);
        doIt(x, y-1, count);
    }

    return;
}
```

What is the output of the following program fragment?

```
int count = 0;

doIt(2, 3, &count);
printf("%d\n", count);
```

*Ans. 3.*

5. You are tasked to decode a message. Each letter in the original message has been shifted four places to the left in the alphabet. So to decode, each letter has to be shifted four places right with wrap-around, a should be e, z should be d, and so on.

As an example, the coded message:

zk ukq hkra yo1010?

should be decoded to become:

do you love cs1010?

You are given the following decode function.



```

void decode(char *str) {
    while (*str != '\0') {
        if (*str >= 'a' && *str <= 'z') {
            // code fragment
        }
        str++;
    }
}

```

Assuming that the message is written using lower case letters, which of the following code fragments perform the decoding on string `str`?

i. `*str += 4;`  
     `if (*str > 'z') {`  
         `*str -= 26;`  
     `}`

ii. `*str -= 22;`  
     `if (*str < 'a') {`  
         `*str += 26;`  
     `}`

iii. `*str = (*str - 'a' + 4)%26 + 'a';`

*Ans. All i, ii and iii work.*

### 3 Java

1. What is the output of the following program fragment?

```
int sum[] [] = new int[4][4];
for (int k = 0; k < 4; k++) {
    sum[k][0] = 1;
}
for (int k = 0; k < 4; k++) {
    sum[0][k] = 1;
}
for (int m = 1; m < 4; m++) {
    for (int n = 1; n < 4; n++) {
        sum[m][n] = sum[m-1][n-1] + sum[m][n-1];
    }
}

System.out.println(java.util.Arrays.toString(sum[3]));
```

*Ans. 1 2 4 8.*

2. Suppose  $n$  is an integer within the range  $[1, 10]$  (both inclusive). What does the following method  $f(n)$  return?

```
public static int f(int n) {
    if (n == 1) {
        return 1;
    } else {
        return f(n-1) + 1 + f(n-1);
    }
}
```

*Ans.  $2^n - 1$ .*

3. A **Fibonacci** sequence is a series of numbers that begins with 1, 1, 2, 3, 5, 8, .... In the following program fragment, the output from variable `seq` forms the first 5 terms of a Fibonacci sequence. However, its line 7 is hidden from you (shown below as `XXXXXXXXXXXXXX`).

```
int n = 5, seq = 0, t = 1;
for (int i = 1; true; i++) {
    if (i > n) {
        break;
    }
    t += seq;
    XXXXXXXXXXXXXXXX
    System.out.println("seq = " + seq + ", t = " + t);
}
```

When executing this code, it prints out the following results:

```
seq = 1, t = 1.
seq = 1, t = 2.
seq = 2, t = 3.
seq = 3, t = 5.
seq = 5, t = 8.
```

Which statement can be used in line 7 to produce this output?

*Ans.* `seq = t - seq;`

## 4 Javascript

1. What should the output be when the following Javascript program is executed using the Chrome Browser Developer Tool Console?

```
var x = "A";
function foo(){
    var y = x;
    var x = "B";
    console.log(x);
    console.log(y);
}
foo();
console.log(x);
```

*Ans. undefined ; A .*

2. What should the output be when the following Javascript program is executed using the Chrome Browser Developer Tool Console?

```
var a = 10;
function f1(x){
    function f3(x){
        return x + x;
    }

    return function(y){
        return f3(x) + y(x);
    }
}

function f2(x){
    return x * x;
}

console.log(f1(a)(f2));
```

*Ans. 120.*

3. What should the output be when the following Javascript program is executed using the Chrome Browser Developer Tool Console?

```
var a = 10;
function f1(x){
    function f3(x){
        return x + x;
    }

    return function(y){
        return f3(x) + y(x);
    }
}

function f2(x){
    return x * x;
}

console.log(f1(f2)(a));
```

*Ans. Runtime error.*

## 5 Python

For Questions 1–3, consider the following function definition:

```
def foo(s):  
    if s:  
        s[0], s[-1] = s[-1], s[0]  
        return foo(s[1:-1])  
    else:  
        return s
```

What is the output of the following statements?

1. `print(foo('banana'))`

*Ans. An error occurs. In Python, strings are immutable. The line `s[0], s[-1] = s[-1], s[0]` attempts to modify the string, which causes an error.*

2. `print(foo(list('banana')))`

*Ans. Nothing is printed. The input argument is now first converted into a list, which is mutable, so no error unlike previously. On the surface it might appear to be reversing the list by swapping the first and last elements, and recursively calling the middle, which it does. But the return statement at the base case returns the input, which is an empty string. It is this return value that gets back-propagated up the call stack and eventually printing an empty string will not display anything.*

3. `l = list('banana')`  
`foo(l)`  
`print(''.join(l))`

*Ans. None of the above. What gets printed is **aaanab**, where only the first and last characters are swapped. This is because slicing the middle of the string to make the recursion call creates a new string. So the input argument is only modified once in the first function call. Hence, only the first and last characters are swapped.*

4. What the the output when the following code is entered into the Python shell?

```
python
>>> sorted(filter(lambda x: x%2,
...                map(lambda x: x**2,
...                    range(10))),
...        key=lambda x:x%10)
```

*Ans. [1, 81, 25, 9, 49]. The filter function in Python keeps elements whose condition evaluates to **True**. In Python, numeric value 0 is taken to mean **False**, or **True** otherwise. This means the filter will keep objects that satisfy the condition `x%2`. This means if the input is even, `x%2` will evaluate to 0, which means to skip.*

5. What are the contents of the variables `a`, `b` and `c` after executing the following statements?

```
a = [1, 2]
b = [a, a]
c = a.copy()
c[0], a[1] = b[1], c[0]
```

*Ans: a: [1, 1]  
b: [[1, 1], [1, 1]]  
c: [[1, 1], 2]*

*In Python, lists are objects stored as references. Also, multiple assignments in the same line are done atomically.*

6. What is the output of the following code:

```
s = "Lillypilly"
d = {}
for i, j in enumerate(s):
    d[j] = i%4
print(d)
```

*Ans. 'l': 0, 'i': 2, 'l': 0, 'y': 1, 'p': 1. Dictionaries have unique keys and later assignment simply overwrites the value of the old key.*